



October 30, 2020

Ms. Karlene Fine  
Executive Director  
North Dakota Industrial Commission  
600 East Boulevard Avenue, Department 405  
State Capitol, 14th Floor  
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Quarterly Progress Report for the Period of July 1 – September 30, 2020, “PCOR Initiative to Accelerate CCUS Deployment”; Contract Nos. FY20-XCI-226 and G-050-096

Attached please find the Energy & Environmental Research Center (EERC) Quarterly Progress Report for the subject project. If you have any questions, please contact me by phone at (701) 777-5236 or by e-mail at [kconnors@undeerc.org](mailto:kconnors@undeerc.org).

Sincerely,

DocuSigned by:  
  
1D14EF7CF3CD456...  
Kevin C. Connors  
Principal Policy & Regulatory Strategist

KCC/rlo

Attachment

c/att: Michael Holmes, Lignite Energy Council  
Brent Brannan, North Dakota Industrial Commission (NDIC) Department of Mineral  
Resources, Oil and Gas Division

c: Corey Irion, EERC



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# PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT

Quarterly Technical Progress Report

*(for the period July 1 – September 30, 2020)*

*Prepared for:*

Karlene Fine

North Dakota Industrial Commission  
600 East Boulevard Avenue, Department 405  
State Capitol, 14th Floor  
Bismarck, ND 58505-0840

Contract Nos. FY20-XCI-226 and G-050-96

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October 2020

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## **ACKNOWLEDGMENT**

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Plains CO<sub>2</sub> Reduction (PCOR) Partnership  
Energy & Environmental Research Center (EERC)

**PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT**  
**Quarterly Progress Report**  
**July 1 – September 30, 2020**

## **EXECUTIVE SUMMARY**

The Plains CO<sub>2</sub> Reduction (PCOR) Partnership Initiative is one of four projects competitively awarded by the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) under the Regional Initiative to Accelerate CCUS (carbon capture, utilization, and storage). The PCOR Partnership Initiative is led by the Energy & Environmental Research Center (EERC) with support from the University of Wyoming (UW) and the University of Alaska Fairbanks (UAF) and includes stakeholders from the public and private sectors. The PCOR Partnership Initiative region includes all or part of ten U.S. states and four Canadian provinces.

Additional funding of \$5,000,000 was awarded by DOE for the additional scope of work. The EERC began contract modifications with sponsors North Dakota Industrial Commission (NDIC) Oil and Gas Research Program and NDIC Lignite Research Program and subrecipients UAF and UW.

A decision was made to move the in-person annual membership meeting to June 2021 in Jackson, Wyoming, because of the COVID-19 situation and travel restrictions for many companies. In lieu of an in-person meeting in 2020, a series of virtual presentations will be held between September 2020 and March 2021 on a variety of topics. The kickoff webinar was held on September 23, 2020.

Writing continued on the storage optimization report. The project team has completed the testing of the NRAP (National Risk Assessment Partnership) tool, RROM-Gen (Reservoir Reduced-Order Model – Generator). A draft of the risk-based area of review report was prepared and is undergoing internal review. A virtual Technical Advisory Board meeting was held August 4, 2020, to discuss the PCOR Partnership road map vision for the next 5 years and development of the webinar series.

The EERC holds an unwavering commitment to the health and well-being of its employees, partners and clients, and the global community. As such, precautionary measures have been implemented in response to COVID-19. Staff continue to carry out project-related activities remotely, and personnel supporting essential on-site laboratory and testing activities are proceeding under firm safety guidelines. Travel has been minimized, and protective measures are being undertaken for those who are required to travel. At this time, work conducted by EERC employees is anticipated to progress with minimal disruption. Challenges posed by economic

variability will be met with open discussion between the EERC, the DOE Project Manager, and other partners to identify solutions. The EERC is monitoring developments across the nation and abroad to minimize risks, achieve project goals, and ensure the success of our partners and clients.



**PCOR PARTNERSHIP INITIATIVE TO ACCELERATE CCUS DEPLOYMENT**  
**Quarterly Progress Report**  
**July 1 – September 30, 2020**

## **INTRODUCTION**

The Plains CO<sub>2</sub> Reduction (PCOR) Partnership Initiative is one of four projects operating under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Initiative to Accelerate CCUS (carbon capture, utilization, and storage). The PCOR Partnership Initiative is led by the Energy & Environmental Research Center (EERC) with support from the University of Wyoming (UW) and the University of Alaska Fairbanks (UAF) and includes stakeholders from the public and private sectors. The membership, as of September 30, 2020, is 190 members. The PCOR Partnership Initiative region includes all or part of ten states (Alaska, Iowa, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming) and four Canadian provinces (Alberta, British Columbia, Manitoba, and Saskatchewan).

The goal of the PCOR Partnership Initiative is to identify and address onshore regional storage and transport challenges facing commercial deployment of CCUS in an expanded region, compared to past initiatives. To achieve this goal, the PCOR Partnership Initiative will meet the following objectives:

1. Address key technical challenges by advancing critical knowledge and capabilities
2. Facilitate data collection, sharing, analysis, and collaboration
3. Evaluate regional infrastructure challenges and needs
4. Promote regional technology transfer

The project goal and objectives will be accomplished through five tasks over two budget periods (BPs), corresponding to a 5-year period of performance. The EERC and project partners will collaborate to identify and address technical challenges facing deployment of CCUS in multiple categories, including stacked storage opportunities, CO<sub>2</sub> storage performance and monitoring, and risk assessment. Existing data sets and technologies will be analyzed and evaluated to highlight current challenges limiting commercial adoption of CCUS, as well as to identify potential solutions. The project team will support the DOE National Risk Assessment Partnership (NRAP) and machine-learning (ML) initiatives by drawing on data sets and experience available through the team. Assessments of infrastructure, site readiness, techno-economics, and socioeconomics will provide an overview of the CCUS landscape within the defined PCOR Partnership Initiative region. Potential business case scenarios will be evaluated, taking into account current economic incentives to identify opportunities in CCUS project development. Technology transfer activities will inform and educate CCUS stakeholders of

project learnings through annual membership meetings, regulatory roundup meetings, Technical Advisory Board (TAB) meetings, webinars, reports, and conference presentations/papers. These activities will facilitate knowledge sharing and support DOE program goals.

## ACCOMPLISHMENTS

### **Task 1.0 – Project Management and Planning**

The objective of Task 1.0 is to manage and direct the project in accordance with a Project Management Plan (PMP) to meet all technical, schedule, and budget objectives and requirements. Activities will be coordinated in order to effectively accomplish the work. The project manager will ensure that project plans, results, and decisions are appropriately documented and project reporting and briefing requirements are satisfied.

Significant accomplishments for Task 1.0 during the reporting period include the following:

- Submitted statement of project objectives (SOPO) revisions and budget allocations for the DOE FY2020 add-on funding to DOE on July 16, 2020. DOE Contract Modification 003 was received September 4, 2020, increasing the DOE award from \$5,000,000 to \$10,000,000. The revised SOPO and budget were included. The EERC began contract modifications with sponsors North Dakota Industrial Commission (NDIC) Oil and Gas Research Program and NDIC Lignite Research Program and subrecipients UAF and UW.
- Began SOPO and budget allocation revisions for the next round of add-on funding.
- Presented “Plains CO<sub>2</sub> Reduction (PCOR) Partnership Initiative (FE0031838)” at DOE NETL’s 2020 Virtual Integrated Project Review Meeting on August 17, 2020. The meetings held August 17–19, 2020, were focused on CCUS integrated projects.
- Presented “Plains CO<sub>2</sub> Reduction Partnership Initiative to Accelerate Carbon Capture, Utilization, and Storage Deployment (FE0031838)” at the DOE NETL Carbon Storage Virtual Project Review Meeting on September 8, 2020.
- Moved the in-person annual membership meeting to June 2021 in Jackson, Wyoming, because of the COVID-19 situation and travel restrictions for many companies. In lieu of an in-person meeting in 2020, a series of virtual presentations will be held between September 2020 and March 2021 on a variety of topics. Activities included the following:
  - Performed hotel venue site visit in Jackson, Wyoming, on August 31, 2020.
  - Sent an e-blast to partners informing of the kickoff webinar of the PCOR Partnership webinar series.
  - Held the kickoff webinar on September 23, 2020. The PCOR Partnership Initiative Principal Investigator (PI) introduced the participants to the expanded PCOR

Partnership region and provided an overview of the project. Brent Sheets and Dr. Vahid Atashbari provided an overview of CO<sub>2</sub> enhanced oil recovery (EOR) in Alaska and plans for work to be performed by UAF. Erin Phillips described UW's collaborative efforts in the project. At the end of the webinar, the participants were asked three multiple choice questions of value to the project. The webinar was attended by 64 external and 29 EERC participants. The slides are provided in Appendix A.

- Worked on planning the next webinars in the series.
- Engaged in conversations with current and prospective partners regarding their continued involvement in the PCOR Partnership Initiative.
- Mailed PCOR Partnership DVDs and an atlas as a result of a web request.

Next steps to accomplish the goals under Task 1.0 include the following:

- Complete add-on SOPO revisions and budget and submit to DOE.
- Continue webinar series planning and hold a webinar.
- Track progress on project deliverables (D) and milestones (M) (see Tables 1 and 2).

### **Task 2.0 – Technical Challenges**

In Task 2.0, the project team will support regional deployment of CCUS programs by focusing on key technical challenges in the PCOR Partnership Initiative region related to stacked storage opportunities; storage performance; monitoring, verification, and accounting (MVA) technology; and subsurface integrity. The EERC will collaborate with PCOR Partnership Initiative members to identify knowledge gaps and address regional challenges through targeted webinars, workshops, reports, and papers.

Progress on Task 2.0 is as follows:

- Continued gathering information for and initiated writing of the storage optimization report (D2). Created a simulation matrix that examines technologies (namely, injector count, brine production, and horizontal wells) to optimize CO<sub>2</sub> storage performance and currently finalizing the matrix of proposed simulations to efficiently accomplish the report objectives.

Next steps to accomplish the goals under Task 2.0 in the coming quarter include the following:

- Conduct simulations as outlined in the finalized simulations matrix.
- Submit D2, Report – Storage Optimization.

**Table 1. Project Deliverables**

<b>Deliverable (D) No. and Title</b>	<b>Planned Completion Date</b>	<b>Actual Completion Date</b>	<b>Verification Method</b>	<b>Comments</b>
D1 – Project Management Plan	30 days after contract definitization	2/21/2020	PMP file submitted to DOE Project Manager (PM)	
D2 – Report – Storage Optimization	12/31/2020		Topical report submitted to DOE PM	
D3 – Report – Stacked Storage Opportunity Assessment	6/30/2021		Topical report submitted to DOE PM	
D4 – Report – Regional Business Case Assessment	6/30/2021		Topical report submitted to DOE PM	
D5 – Report – Subsurface and Legacy Well Integrity	12/31/2021		Topical report submitted to DOE PM	
D6 – Report – MVA Strategies	6/30/2022		Topical report submitted to DOE PM	
D7 – Report – Evaluation of Risk Management	9/30/2022		Topical report submitted to DOE PM	
D8 – Report – Regional Permitting Guidance	9/30/2022		Topical report submitted to DOE PM	
D9 – Report – Infrastructure, Scale-Up, and Techno-Economic Assessments	12/31/2022		Topical report submitted to DOE PM	
D10 – Report – NRAP Testing and Validation	3/31/2023		Topical report submitted to DOE PM	
D11 – Report – Basement Faulting and Stress State, Induced Seismicity	9/30/2023		Topical report submitted to DOE PM	
D12 – Report – Regional Socioeconomic Assessments	9/30/2023		Topical report submitted to DOE PM	
D13 – Report – Updated Regional Business Case Assessment	12/31/2023		Topical report submitted to DOE PM	
D14 – Report – Risk-Based Area of Review	12/31/2020		Topical report submitted to DOE PM	
D15 – PCOR Partnership Atlas	3/31/2021 and 3/31/2023		Atlas submitted to DOE PM	

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**Table 2. Milestone Status Report**

<b>Milestone (M) No. and Title</b>	<b>Planned Completion Date</b>	<b>Actual Completion Date</b>	<b>Verification Method</b>	<b>Comments</b>
M1 – Regulatory Roundup Scheduled	2/29/2020	3/31/2020	Reported in subsequent quarterly report	
M2 – Initial Techno-Economic Framework Established	4/30/2020	4/28/2020	Reported in subsequent quarterly report	
M3 – Annual Meeting Scheduled	3/31/2021		Reported in subsequent quarterly report	
M4 – Regulatory Roundup Scheduled	3/31/2021		Reported in subsequent quarterly report	
M5 – Data Share with National Lab for NRAP Assessment	6/30/2021		Reported in subsequent quarterly report	
M6 – GHGT-16 <sup>1</sup> Abstract Submitted	1/31/2022		Reported in subsequent quarterly report	
M7 – BP1 EDX <sup>2</sup> Submitted	3/31/2022		Reported in subsequent quarterly report	
M8 – Draft Journal Article Completed	11/30/2022		Reported in subsequent quarterly report	
M9 – Regulatory Roundup Scheduled	3/31/2023		Reported in subsequent quarterly report	
M10 – GHGT-17 Abstract Submitted	1/31/2024		Reported in subsequent quarterly report	
M11 – Annual Meeting Scheduled	3/31/2024		Reported in subsequent quarterly report	
M12 – BP2 EDX Submitted	6/30/2024		Reported in subsequent quarterly report	

<sup>1</sup> 16th International Conference on Greenhouse Gas Control Technologies.

<sup>2</sup> Energy Data eXchange.

### **Task 3.0 – Data Collection, Sharing, and Analysis**

In Task 3.0, the project team will collaborate with other DOE Fossil Energy (FE)-funded researchers to improve understanding of CO<sub>2</sub> injection and storage impacts. The project team will work with national laboratories to facilitate data sharing, support the development and validation of NRAP tools with site-specific data, and participate in development of ML-based tools/methods in a commercial setting.

Progress on Task 3.0 is as follows:

- Subtask 3.1 – Data Sharing:
  - The EERC has compiled details of several commercial-scale geologic models (geomodels) that were developed in Schlumberger’s Petrel and their associated numerical reservoir simulations that were conducted using Computer Modelling Group’s Generalized Equation-of-State Model compositional reservoir simulator, GEM (CMG GEM). This modeling and simulation catalog also includes attributes about the different models, for example: file types, file sizes, model domain, reservoir layers, simulation time, injection wells, and CO<sub>2</sub> mass injection targets. The

modeling and simulation catalog will help to identify potential files that could be shared to accelerate CCUS technology development. In addition, the catalog will provide a basis for NRAP tool testing in Subtask 3.2.

- Subtask 3.2 – NRAP Validation:
  - The project team attended the following NRAP webinars:
    - July 7, 2020: NRAP Webinar Series, Webinar #20 – Geomechanical Risk Assessment Using the State of Stress Analysis Tool (SOSAT)
    - July 21, 2020: NRAP Webinar Series, Webinar #21 – Short-Term Seismic Forecasting – A Tool to Assess Seismicity During Injection Operations
  - NRAP tools testing is ongoing with the following activities:
    - RROM-Gen testing: The project team has completed the testing of the NRAP tool, RROM-Gen (Reservoir Reduced-Order Model – Generator, Version: 2016.11-1.2) and successfully 1) imported the outputs from three different numerical simulations from CMG-GEM into RROM-Gen and 2) processed these data within RROM-Gen to generate three output files, one for each of the reservoir simulations. The purpose of RROM-Gen is to translate the CMG GEM output into a format amendable to analysis in NRAP-Open-IAM (open-source Integrated Assessment Model for Phase II of NRAP).
    - Customized MATLAB programming: The output file from the current version of RROM-Gen is not compatible with the current version of NRAP-Open-IAM. To rectify this problem and move forward with the NRAP-Open-IAM testing, the EERC developed a customized script in MATLAB that converts the RROM-Gen output file into an input format that can be imported into the current version of NRAP-Open-IAM.
    - NRAP-Open-IAM testing: The project team has completed a set of stochastic simulations using NRAP-Open-IAM to quantify potential impacts to groundwater from leakage of brine and/or CO<sub>2</sub> through leaky wellbores in the storage complex. The NRAP-Open-IAM modeling evaluates scenarios where a saline aquifer (thief zone) is present between the cap rock and the underground source of drinking water (USDW) and explores the sensitivity of the results to assumptions about the effective permeability of the leaky wellbores.
    - DREAM testing: The testing of DREAM v2 (Designs for Risk Evaluation and Management, Version: 2020.01-2.0) has been initiated.
    - The results of the RROM-Gen, NRAP-Open-IAM, and DREAM testing will be compiled into a summary report (D10).
  - A representative of DOE NETL asked the EERC to participate in a new SBIR (Small Business Innovation Research) that was awarded to Illinois Rocstar LLC to build a tool based on NRAP-Open-IAM, but with a commercial-quality, well-designed user interface and a seamless distribution platform (potentially cloud-based).
  - A draft of the risk-based area of review (AoR) manuscript (D14) was prepared and is undergoing internal review. The target audience is regulatory stakeholders and entry-level geoscientists. AoR assessment is being done using a revised Fortran model that has been adapted to accommodate initial conditions where the storage reservoir is in a state of relative overpressure to the lowermost USDW.

- Subtask 3.3 – Machine Learning:
  - The EERC continues to support the SMART (Science-Informed Machine Learning for Accelerating Real Time Decisions in Subsurface Applications) Initiative through the PCOR Partnership Initiative. The EERC is directly involved in Tasks 1, 2, 4, 5, and 6 of the SMART Initiative and is participating in the crosscutting groups for algorithms and data.

Next steps to accomplish the goals under Task 3.0 in the coming quarter include the following:

- Subtask 3.1: Continue to catalog available geomodels and reservoir simulations that could be shared to accelerate CCUS technology development.
- Subtask 3.2: Continue to participate in the NRAP webinar series to learn about existing and forthcoming NRAP tools. Continue to troubleshoot and test the suite of NRAP tools described above. Meet with Illinois Rocstar LLC to provide feedback about NRAP-Open-IAM. Summarize the RROM-Gen, NRAP-Open-IAM, and DREAM testing results into D10 (Report – NRAP Testing and Validation).
- Subtask 3.3: Continue to track SMART Initiative activities to identify opportunities to leverage CO<sub>2</sub> storage project data sets for the validation and testing of ML-based approaches to modeling CO<sub>2</sub> and/or pressure in the subsurface.

#### **Task 4.0 – Regional Infrastructure**

The objective of Task 4.0 is to evaluate the regional needs, challenges, and potential economic impacts related to the development of safe and environmentally sound CO<sub>2</sub> transportation infrastructure to accelerate commercial CCUS project deployment. This evaluation will be accomplished by assessing existing infrastructure, scale-up challenges and needs, and techno-economic and socioeconomic impacts in the PCOR Partnership Initiative region and will be communicated through outreach activities.

Progress on Task 4.0 is as follows:

- Worked on updating CO<sub>2</sub> emission sources map for the PCOR Partnership Initiative region.
- Presented to the North Dakota Ethanol Council on August 27, 2020, describing the PCOR Partnership Initiative, CCUS opportunities, and North Dakota regulations.

Next steps to accomplish the goals under Task 4.0 in the coming quarter include the following:

- Develop a preliminary plan for acquiring input data for statewide economic models within the PCOR Partnership Initiative region.

## **Task 5.0 – Technology Transfer**

Task 5.0 will inform and educate stakeholders about CCUS technologies. Nontechnical challenges to CCUS deployment in the PCOR Partnership Initiative region will be identified and assessed, with an emphasis on regulatory issues and solutions. Business case scenarios for CCUS projects will be identified, reviewed, and developed. Outcomes of this task will be transferred to stakeholders through meetings, presentations, and webinars. Developed materials will be shared with DOE to support its broader FE program goals.

Progress on Task 5.0 is as follows:

- Held a virtual TAB meeting on August 4, 2020. Discussion included an update on the PCOR Partnership Initiative, the PCOR Partnership road map vision for the next 5 years, and development of the webinar series. TAB comprises experts in CO<sub>2</sub> storage and CO<sub>2</sub> EOR and consists of the following individuals:
  - Stefan Bachu, industry expert
  - Stacey Dahl, Minnkota Power Cooperative
  - Jim Erdle, CMG
  - Lynn Helms, NDIC
  - Mike Holmes, Lignite Energy Council
  - Steve Meltzer, Melzer Consulting
  - Simon O’Brien, Shell
  - Tom Olle, Lonestar Resources, Inc.
  - Kate Ryan, Denbury Resources
- Researched original monitoring, reporting, and verification (MRV) documents and federal guidelines on MRV plans relating to Class VI permits. A template for an MRV plan for PCOR Partnership Initiative membership was developed in support of permitting Class VI injection wells for commercial deployment. The MRV template was reviewed internally.
- Initiated activities related to Section 45Q tax credits and business model development for Section 45Q implementation.
- Prepared a draft 2025 road map for the PCOR Partnership Initiative region. The vision for the next 5 years includes a description of Commercial Business Models Driving CCUS in the PCOR Partnership Initiative region, identifying the business models that will drive commercial development and what innovations are necessary to accelerate the deployment of new CCUS projects.
- A new PCOR Partnership Initiative website is being developed. During this quarter, the infrastructure and navigation of the site were built and coded, and an initial draft of content was written.

Next steps to accomplish the goals under Task 5.0 in the coming quarter include the following:

- Submit the 2025 road map for the PCOR Partnership Initiative region to DOE.
- Each of the five business cases described in the draft 2025 road map for the PCOR Partnership Initiative will be researched and defined and a plan developed to meet the stated vision. This includes the following:
  - Consider various ownership options.
  - Consider various combinations of capture, transportation, dedicated/associated storage, and production of low-carbon fuels.
  - Provide an assessment of the maturity and potential rate of growth of these business models.
  - Provide guidance on how each business model can leverage existing infrastructure, tax policies, financial incentives, and investment vehicles/insurance instruments to facilitate CCUS commercialization throughout the PCOR Partnership Initiative region.

## **CHANGES/PROBLEMS**

The EERC is operational and open for business. Personnel who are not essential for on-site operations have transitioned to working from home. Essential project, laboratory, and field-based activities are proceeding with the incorporation of the Centers for Disease Control and Prevention (CDC), the state of North Dakota, and the University of North Dakota (UND) guidelines associated with COVID-19, and mitigation measures have been implemented.

In collaboration with project partners, the EERC is continually assessing potential impacts to project activities resulting from COVID-19 and/or the U.S. economic situation.

The situation has impacted planning efforts for the PCOR Partnership Initiative annual meeting. The dates for the annual membership meeting were pushed from June 2020 to June 2021, and a series of webinars were scheduled in lieu of an in-person meeting.

In the event that any potential impacts to reporting, scope of work, schedule, or cost are identified, they will be discussed and addressed in cooperation with project partners.

## **SPECIAL REPORTING REQUIREMENTS**

None.

## **APPENDIX A**

# **WEBINAR SERIES SLIDES – KICKOFF MEETING**



Critical Challenges. Practical Solutions.

1



Energy & Environmental Research Center (EERC)

## Plains CO<sub>2</sub> Reduction (PCOR) Partnership

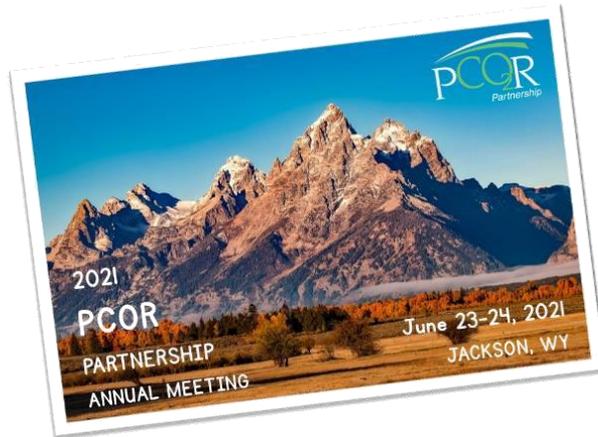
PCOR Partnership Initiative to Accelerate CCUS

September 23, 2020

Kevin Connors

PCOR Partnership Project Manager

2



North Dakota Industrial Commission



## SAVE THE DATE!

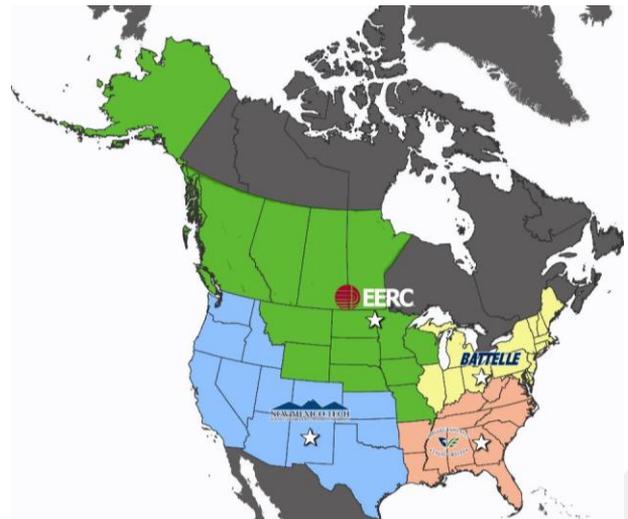
2021 PCOR Partnership Annual Meeting

June 23 (Pre-Event Networking Social)

June 24 (Annual Meeting and Networking Event)

3

## REGIONAL CARBON SEQUESTRATION PARTNERSHIPS (RCSPs)



Critical Challenges. Practical Solutions.

4

# PLAINS CO<sub>2</sub> REDUCTION (PCOR) PARTNERSHIP

2003–2005 – PCOR Partnership: Characterization

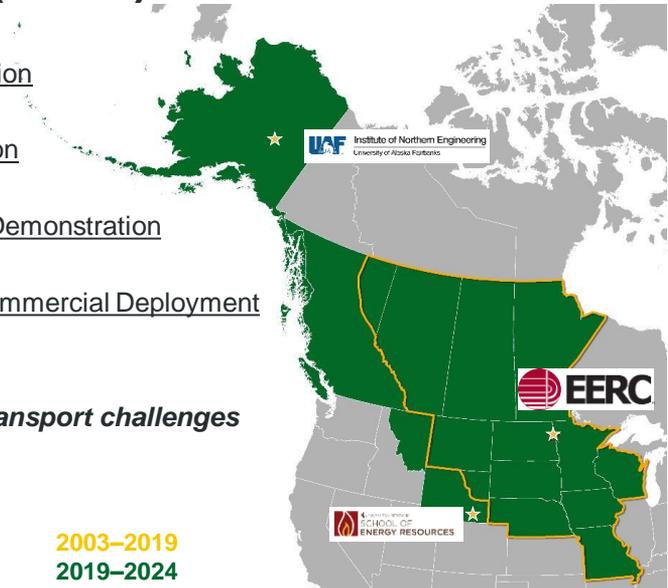
2005–2008 – PCOR Partnership: Field Validation

2007–2019 – PCOR Partnership: Commercial Demonstration

2019–2024 – *PCOR Partnership Initiative*: Commercial Deployment

## Goal:

*Identify and address regional storage and transport challenges facing commercial CCUS deployment.*



2003–2019  
2019–2024



Critical Challenges. Practical Solutions.

5



7/2020

6

## PCOR PARTNERSHIP

### *Five key messages relate to:*

1. Our engaged membership.
2. Outstanding regional CCUS potential.
3. CCUS works! We have demonstrated:
  - a) Low risks of storage.
  - b) Successful monitoring, verification, and accounting (MVA).
4. Economic and environmental benefits.
5. Active public engagement and outreach.

Image credit - EERC

7

## PCOR PARTNERSHIP INITIATIVE

The PCOR Partnership Initiative is addressing regional capture, transport, use, and storage challenges facing commercial CCUS deployment. The Initiative is focusing on:

- Strengthening the technical foundation for geologic CO<sub>2</sub> storage and enhanced oil recovery.
- Advancing capture technology.
- Improving application of monitoring technologies.
- Promoting integration between capture, transportation, use, and storage industries.
- Facilitating regulatory frameworks.
- Providing scientific support to policy makers.



Critical Challenges. Practical Solutions.

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# PCOR PARTNERSHIP INITIATIVE OVERVIEW

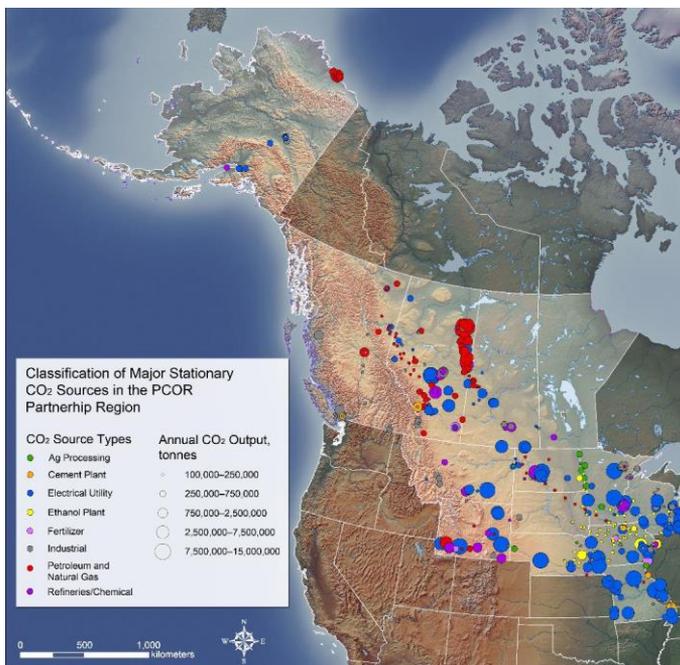


- **Technical and Nontechnical Challenges**
- **Data Collection, Sharing, and Analysis**
- **Regional Infrastructure**



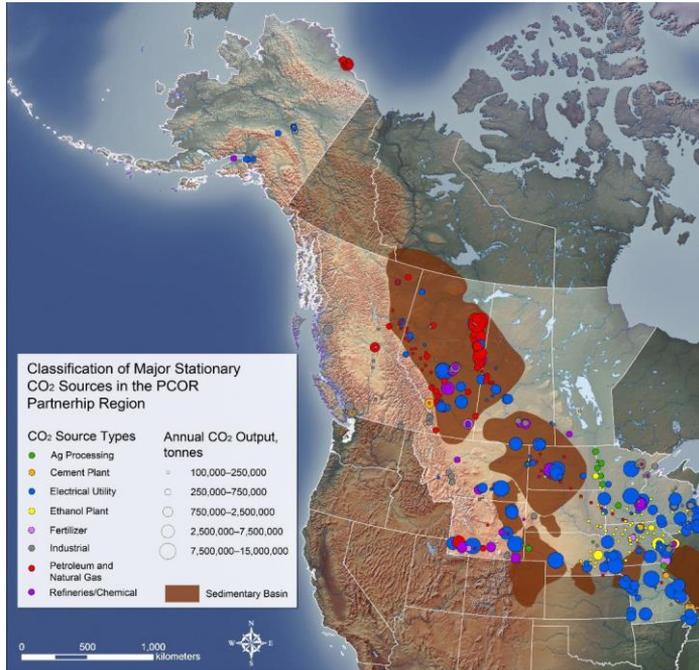
Critical Challenges. Practical Solutions.

# REGIONAL SOURCES



Critical Challenges. Practical Solutions.

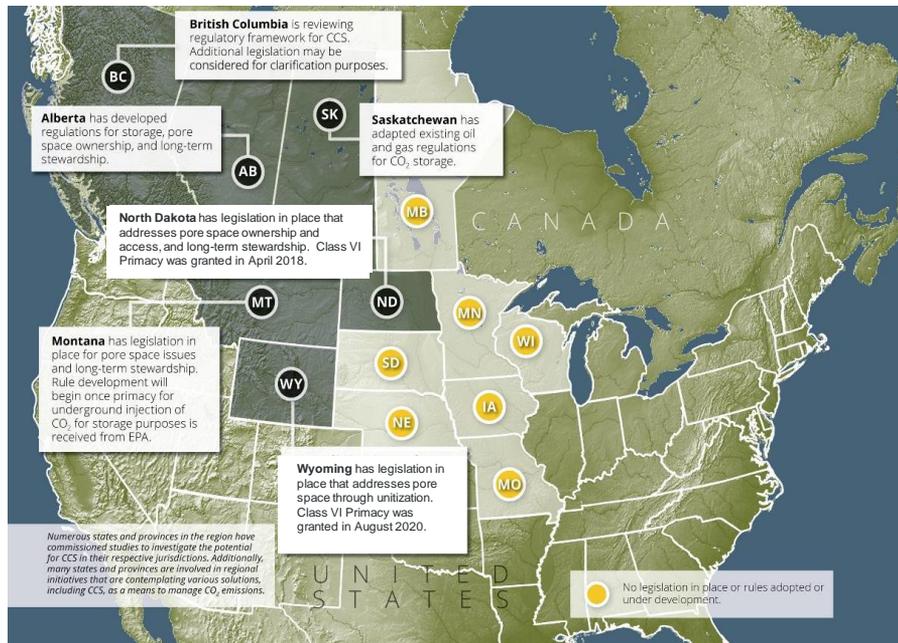
# REGIONAL SOURCES AND SINKS



Critical Challenges. Practical Solutions.

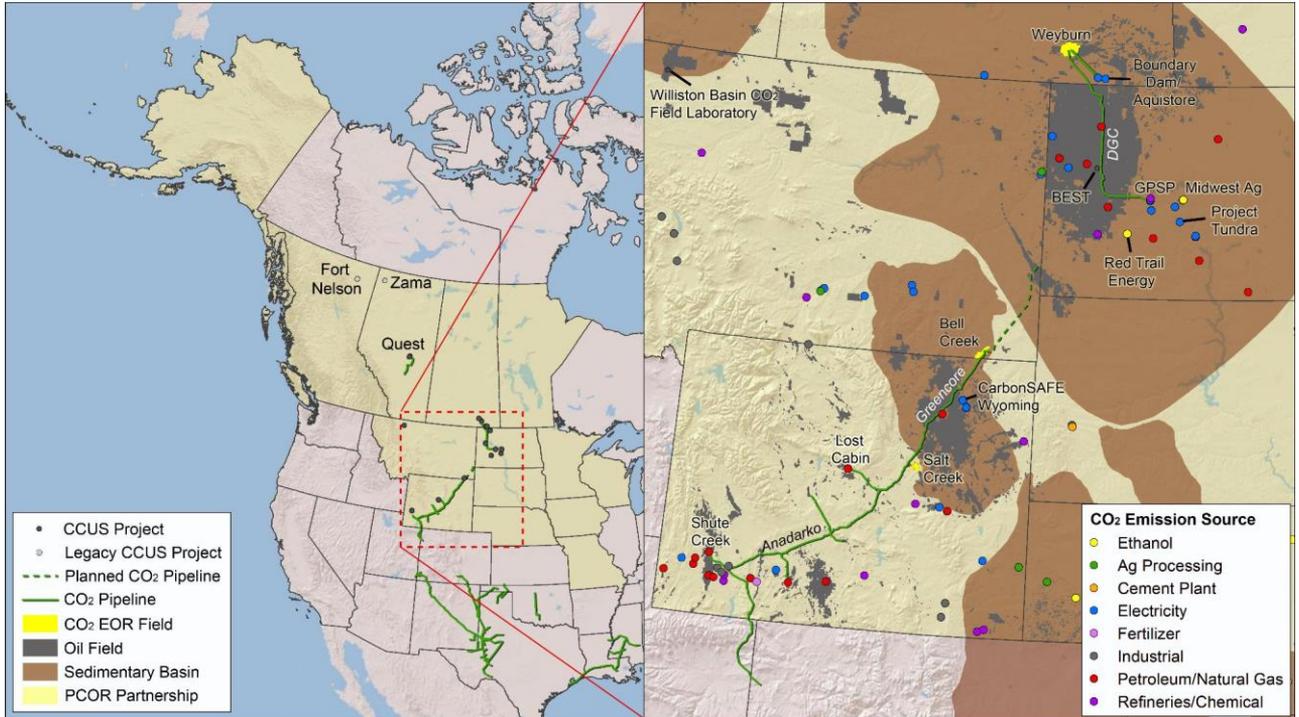
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# ENGAGED REGULATORS



Critical Challenges. Practical Solutions.

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# PCOR PARTNERSHIP INITIATIVE SUMMARY

- Building on over 17 years of applied research in CCUS
- Active region developing commercial CCUS projects
- Catalyst for CCUS projects in the region
- Engaged and motivated partners
- Well-equipped project team

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**PCOR Partnership Project Manager**  
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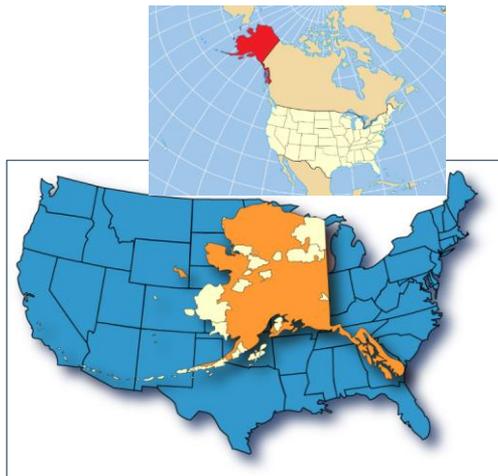
**Energy & Environmental  
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University of North Dakota  
15 North 23rd Street, Stop 9018  
Grand Forks, ND 58202-9018

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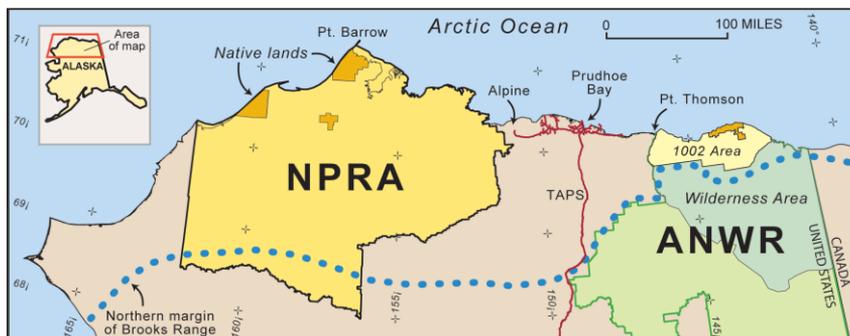
## WHERE IS FAIRBANKS?



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## ALASKA NORTH SLOPE

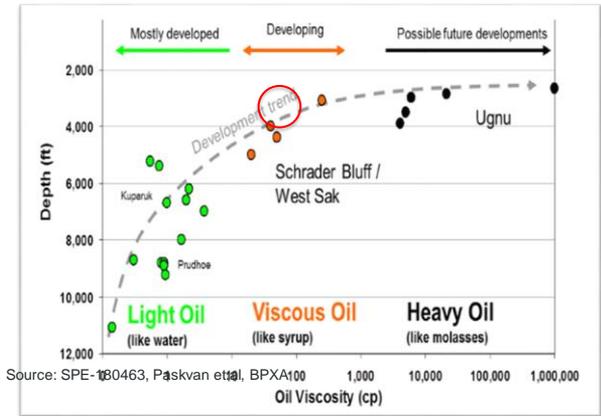


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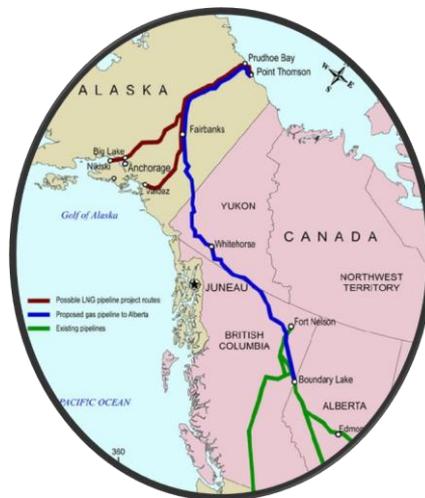
## CO<sub>2</sub> EOR

- Oil Recovery
  - 20+ billion barrels of heavy/viscous oil awaiting technology
  - Available Solvents
    - ◆ Prudhoe Bay Miscible Injectant (PBMI)
    - ◆ NGL
    - ◆ CO<sub>2</sub> (not yet!)



## STRANDED NATURAL GAS

- 35+ Tcf natural gas
- Remote from market
- Current thinking is major export pipeline to a liquefaction facility, then export to Asian market
- Alternative is in-state use only (uneconomic)





## PROJECT OBJECTIVES

- Following discussions with PBU operators, UAF and EERC drafted a SOW to:
  - Evaluate incremental oil production from a North Slope field by initiating high-concentration CO<sub>2</sub> EOR
    - ◆ Includes making estimates about net CO<sub>2</sub> “permanently” sequestered
  - Evaluate the implications of using CO<sub>2</sub> in an “older” field, especially the effectiveness of corrosion inhibitors in the presence of high-concentration CO<sub>2</sub>

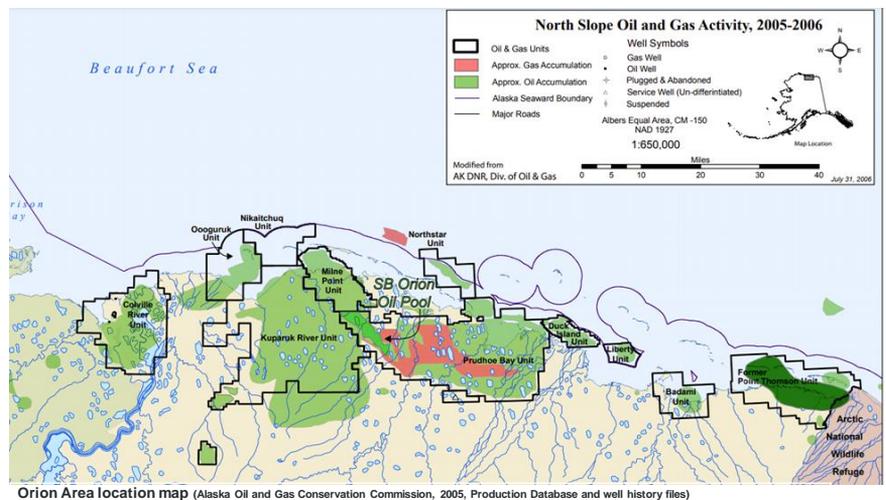
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## PROJECT BACKGROUND

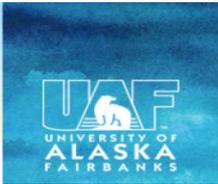
### Orion Field

- Discovered in 1968
- Production started in 2002
- 1,070-1,780 MMB OOIP
- API gravity: 15-25
- Daily production: 4,500 BPD (peaked at 11,000 BPD)

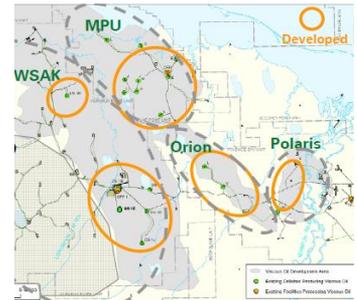
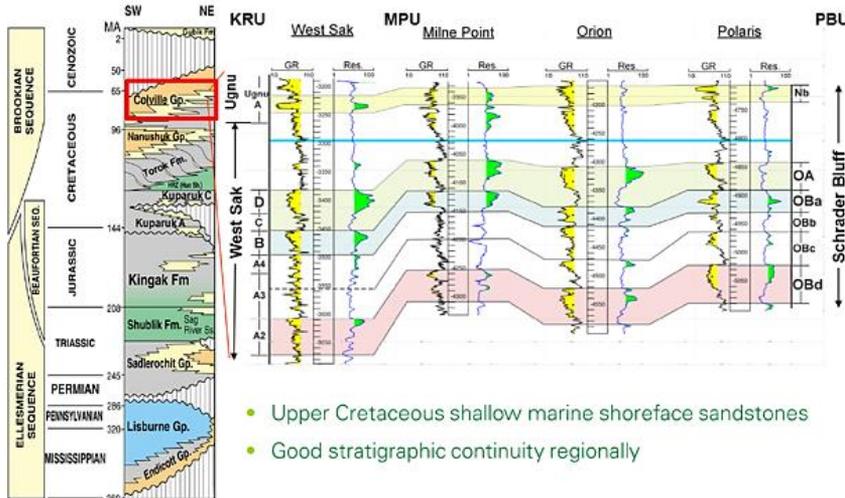


Orion Area location map (Alaska Oil and Gas Conservation Commission, 2005, Production Database and well history files)

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## PROJECT BACKGROUND



- Upper Cretaceous shallow marine shoreface sandstones
- Good stratigraphic continuity regionally

Schradler Bluff reservoir with multiple commercial horizons. (Paskvan et al., 2016)

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## CO<sub>2</sub> ISSUES TO CONSIDER

- Concerning heavy, viscous oil:
- CO<sub>2</sub> needs to be designed into “day 1” production plan, including metallurgy
  - CO<sub>2</sub> supply could greatly exceed PBMI supply, especially if major gas sales occur



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## CONCLUSIONS

- Major gas sales could generate 400mmcf/d of CO<sub>2</sub> stream
- CO<sub>2</sub> is a highly efficient liquid injectant (super critical) at viscous & heavy oil reservoir conditions
- It always comes down to economics



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## THANK YOU



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Dr. Vahid Atashbari (vatashbari@Alaska.edu)

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## Advancing Carbon Capture, Utilization, and Storage: University of Wyoming's Collaborative Efforts in the PCO<sub>2</sub>R Partnership Initiative



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Erin Phillips, Scott Quillinan,  
and Kipp Coddington  
PCOR Initiative Webinar  
September 23, 2020



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## Disclaimer

**Acknowledgment:** This portion of the presentation is based upon work supported by the Department of Energy under Award Numbers DE-FE0031624 and DE-FE0031838.

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## UW School of Energy Resources (SER)

- Established in 2006 and funded separately by the Wyoming State Legislature at ~\$10 million annually
- Our Mission: to develop and deploy expertise to solve critical energy challenges, to add value to the Wyoming energy sector, and to position UW as a primary provider for energy innovation at the national level
- SER faculty in programs across campus; two academic program tracks
- SER research centers include the Center for Economic Geology Research (CEGR), Center for Energy Regulation and Policy Analysis (CERPA), the Enhanced Oil Recovery Institute (EORI), and the Center for Carbon Capture and Conversion
- Dr. Holly Krutka is the new Executive Director of SER



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# University of Wyoming PCOR Scope

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- Characterization
  - Assist with evaluation of dedicated and associated CO<sub>2</sub> storage technical opportunities
  - Compile and share existing data
  - Assess stacked storage complexes across PCOR region, including seal properties, basement faulting, and stress regimes
  - Evaluation of structural geology of Wyoming basins
- Technology Validation
  - Evaluate technologies to ensure storage permanence
  - Build on current understanding of networks of legacy wellbores

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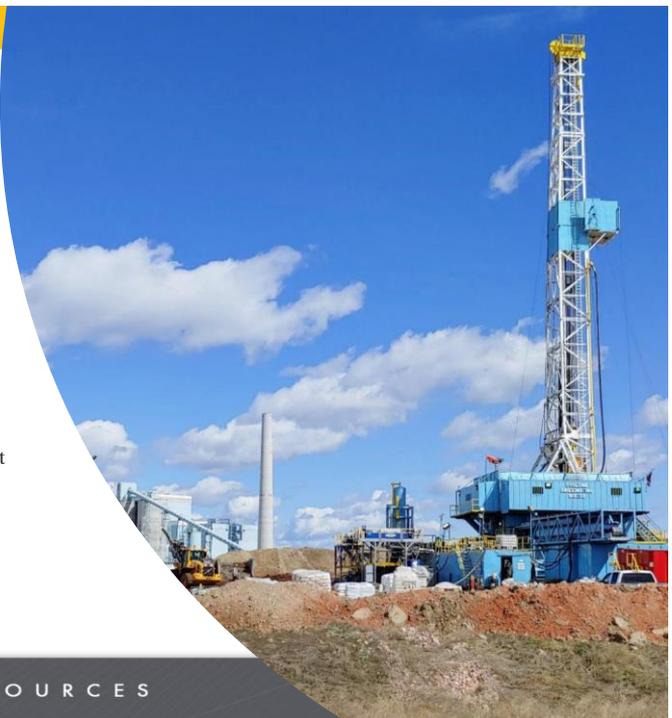
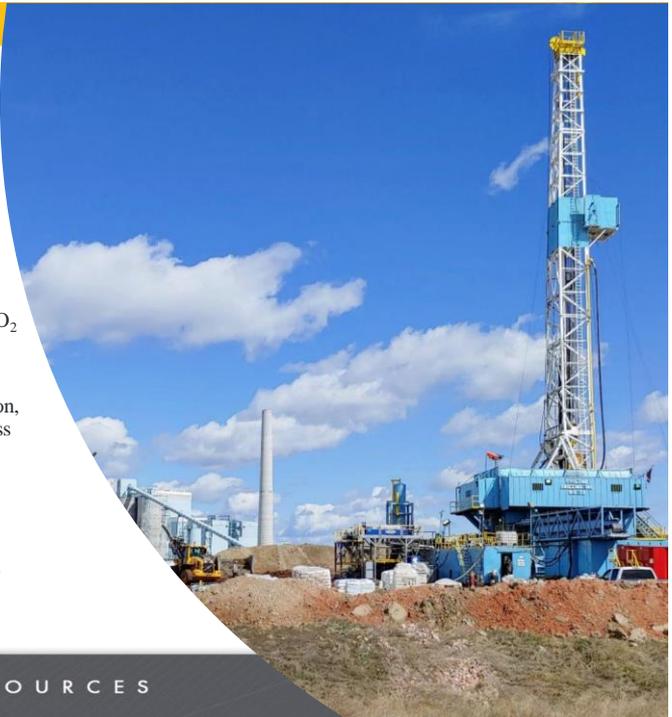
# University of Wyoming PCOR Scope

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- Regional Infrastructure
  - Techno-economic analysis of CO<sub>2</sub> sources, storage targets, and transportation opportunities within Wyoming
  - Provide input on policy progress and scale-up challenges
  - Assess socioeconomic impacts of CCUS development in Wyoming
  - Assist EERC with public and industry outreach
- Technology Transfer
  - Provide input on regulatory frameworks
  - Assist in compiling permitting guidance

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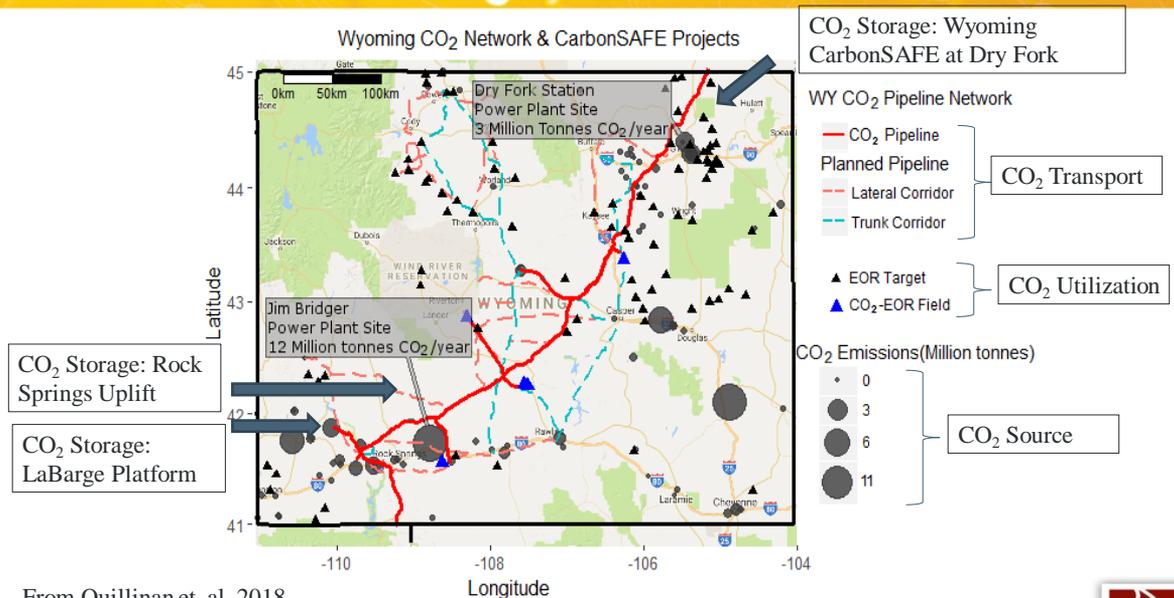


# Wyoming Law, Regulation, and Policy Developments

- WYDEQ’s Class VI Primacy application was approved by the EPA on September 4, 2020
- DOE CCUS Coal-Plant Retrofit Study was published on September 3, 2020
- Wyoming Energy Authority has been formed (July 1, 2020) and Dr. Glen Murrell was named its inaugural executive director
- New laws regarding existing coal-fired power plants have been enacted
  - “Good faith effort” to sell before retiring (SF 159 (2019))
  - Reliable and dispatchable low-carbon energy standards (HB 0200 (2020))
  - Wyoming Public Service Commission assessment underway
- Wyoming’s suite of existing CCUS laws remains in effect (pore space, permitting, trust fund for MRV, etc.)

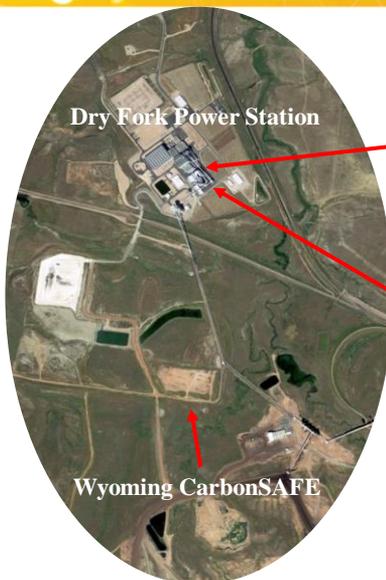


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- Dry Fork Station (Basin Electric Power Cooperative)
  - Built in 2007
  - 385 MW Power Plant
  - 3.3 Million tons of CO<sub>2</sub>/year
- WY Integrated Test Center (ITC)
  - Completed in 2017
  - Test CO<sub>2</sub> capture/CCUS technologies
  - \$20 Million private, state, and federal investment
  - NRG COSIA Carbon XPRIZE



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## Wyoming CarbonSAFE

- DOE funding for Phase III to begin fall 2020
- Phase II
  - Feasibility of stacked storage of CO<sub>2</sub> in saline reservoirs
  - Stratigraphic test well drilled in spring 2019
  - 3D seismic survey completed in August 2020
  - Economic, legal, permitting, and regulatory analysis



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# Public Outreach and Engagement

## CAMPBELL COUNTY PUBLIC LIBRARY

2101 S 4-J Rd, Gillette, WY • Feb. 21, 2019 @ 6:00 PM

Doors open at 5:30 PM for a free, light dinner and snacks.

Moderator: Dr. Jean Gotterson, Professor and Director of the Office of Engagement and Outreach, University of Wyoming



### 6:00 PM - Why Carbon Capture is Important for Wyoming's Economic Future: A Climate Policy Overview

Eddy Coddigan, Director of Energy Policy & Economics, School of Energy Resources (SER), University of Wyoming

One-on-one heat loss from unburned government and private sector resources to reduce their emissions of greenhouse gases such as carbon dioxide (CO<sub>2</sub>). This presentation from international sources such as the Paris Agreement and from national devices, such as California's continuing advancement of a wide range of carbon capture policies. Wyoming's leadership in responding to these challenges through implementation of state-level CO<sub>2</sub> policies and projects will be discussed.



### 6:50 PM - The Science of Carbon Capture, Utilization and Storage (CCUS): Wyoming Case Studies and Wyoming CarbonSAFE

Scott Quilley, Co-chair and Director of Research, School of Energy Resources, UW

David H. England, Ph.D., P.E., Manager of Senior Research Scientist, Center for Economic Geology Research, School of Energy Resources, UW

For the past several years SER has sought to enhance the science of CCUS. One current research aims to provide carbon storage options such as Gillette at the Wyoming Integrated Test Center in support of on-going Carbon Capture research efforts. As well as be prepared to be able to demonstrate storage capacity. How to assess the ramifications of early term commercialization. What are the risks? The risk factor reduction "Wyoming CarbonSAFE", a program that provides that seeks to improve the economic, safe and secure storage of 60 million tons of CO<sub>2</sub> from Gillette.



### 7:40 PM - Carbon Capture and Communities: The Role of Social License

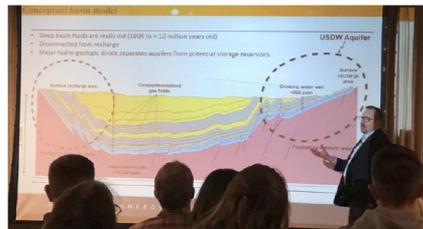
Anna Watson, Ph.D., Senior Research Scientist, Human Dimensions in Natural Resources Division, Collaborative Program in Natural Resources, Richardson Institute, Hank School of Environment and Natural Resources, UW

"Social License" refers to the acceptance of a company or industry standard business practices and operating procedures by its employees, stakeholders and the general public. In the context of CCUS, public acceptance and understanding of the technology and the projects associated with it may be their ultimate success. Dr. Watson will present an overview of the concept of "Social License" and how the industry will be required to participate in a transparent discussion regarding carbon capture and the current research concerning carbon capture in northern Wyoming and the potential impacts on the local communities, from economic and energy to health and the environment.

## Carbon research earning a 'social license' in Gillette

UW CarbonSAFE project will drill more than 10,000 feet into the Powder River Basin

By GREG JOHNSON NEWS RECORD MANAGING EDITOR gjohnson@gillettenewsrecord.net Feb. 22, 2019



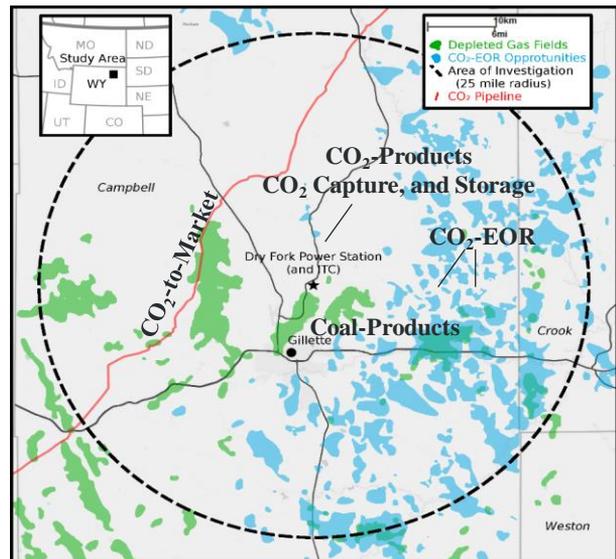
**WHITNEY ACADEMIC CENTER**  
Sheridan College, Sheridan, WY • Feb. 23, 2019 @ 9:00 AM  
Doors open at 8:30 AM for coffee and donuts.



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## “Carbon Valley”

- Capture: WY Integrated Test Center (ITC)
- Transportation: Denbury Greencore Pipeline
- Utilization: CO<sub>2</sub>-EOR and the WY ITC
- Storage: Saline reservoirs (Wyoming CarbonSAFE)
- Coal to products: Wyoming Innovation Center; Three potential REE extraction projects
- Wyoming Energy Authority: seed funds and cost share to advance energy related projects



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# Thank you



And many more...



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## PREVIEW OF UPCOMING WEBINAR SESSIONS

### 2020 Webinars

- States Leading Implementation (October 28)
- Incentivizing CCUS in the Face of Political and Economic Headwinds (November 18)
- December (holiday break – no webinar)

### 2021 Webinars

- CCUS Political Landscape (January 27)
- PCOR Partnership Region Projects: Raising the Bar Globally (February 24)
- Pioneering Commercial CCUS (March 24)

## WHAT DO YOU VIEW AS THE GREATEST BARRIER OR HURDLE TO CCUS DEPLOYMENT?

- A. Policy and regulations
- B. Technical challenges
- C. Finances
- D. Infrastructure
- E. Other

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## WHAT DO YOU SEE AS A GAP IN CCUS DEPLOYMENT FOR YOUR COMPANY OR IN YOUR STATE?

- A. Clear policy and regulations
- B. Public acceptance/Social License
- C. Financial incentives
- D. Other

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## WHICH TECHNICAL CHALLENGES ARE YOU ENCOUNTERING?

- A. Stacked storage opportunities
- B. MVA strategy selection
- C. Risk management
- D. Infrastructure scale-up issues
- E. Other

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THANK YOU



Image credit - EERC

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## ACKNOWLEDGMENT

This material is based upon work supported by the U.S. Department of Energy National Energy Technology Laboratory under Award No. DE-FE0031838.

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